8–16, 18–23 (December 23, 1977) [hereinafter "Staff Report No. 78–1–2"].

[9] Id.

[10] Helen O. Petrauskas, Thomas L. Saybolt, "Memorandum of Ford Motor Company," 5–11 (June 16, 1978) [hereinafter "Ford Memorandum"].

[11] *See Columbia Broadcasting System* v. *United States*, 316 U.S. 407, 416 (1942).

[12] *See* 43 FR 25729 (June 14, 1978) pertaining to 1980 and subsequent model year passenger cars; 43 FR 1829 (January 12, 1978) pertaining to 1981–1982 light duty trucks and medium duty vehicles; 43 Fed. Reg. 15490 (April 13, 1978) pertaining to 1983 and subsequent model year light duty trucks and medium duty vehicles.

[13] *Adamo Wrecking Co.* v. *United States* ———— *U.S.* ————, 98 S.Ct. 566, 579, 54 L.Ed.2d 538, 549 (1978).

[14] State of California Air Resources Board, *Resolution 78–4* at 2 (January 25, 1978); *Staff Report No. 78–1–2* at 25.

[15] U.S. Environmental Protection Agency (EPA), Mobile Source Pollution Control Advisory Circular No. 24, "Prohibition of Use of Emission Control Defeat Devices" (December 11, 1972) (hereinafter "A/C No. 24"). A complete definition of "Defeat Device" appears in A/C No. 24 at 2.

[16] A/C No. 24 at 3.

[17] U.S. EPA, Office of Mobile Source Air Pollution Control Advisory Circular No. 24–2, "Prohibition of Emission Control Defeat Devices—Optional Objective Criteria", December 6, 1978 (hereinafter "A/C No. 24–2"). The guideline HwFET NOx values are 1.22 times the applicable the applicable FTP NOx standard for light duty vehicles and 1.28 times the applicable FTP NOx standard for light duty trucks. A/C No. 24–2 at 3.

[18] Tr. 64–68, 89–91, 126; "American Motors Corporation Comments to the May 18, 1978 EPA Waiver Hearing on the California Highway Cycle NOx Standard" [hereinafter "AMC's EPA Submission"] at 1–2, submitted with AMC May 9, 1978 Letter (see note 23, infra.).

[19] Tr. 20–22.

[20] Tr. 12–14, 19–20, *Staff Report No. 78–1–2* at 1–16, 18, 23–25; CARB June 16, 1978 Letter 2–3.

[21] *Staff Report No.* 78–1–2 at 1–10, 16, 18.

[22] Tr. 9–92, 103–104.

[23] "American Motors Corporation Response To The California Air Resource Board Proposed Highway Cycle Emissions Standards For the 1980 and Later Passenger Cars, Light-Duty Trucks and Medium-Duty Vehicles", submitted with Letter from Stuart R. Perkins, Director Vehicle Emissions and Fuel Economy, American Motors Corporation to Mr. Benjamin R. Jackson, Director MSED, EPA (May 9, 1978) [hereinafter "AMC May 9, 1978 Letter"].

[24] See note 17, *supra*.

[25] Letter from Douglas M. Costle, Administrator, EPA, to D. A. Jensen, Director, Automotive Emissions and Fuel Economy Office, Ford Motor Company at 2 (November 1, 1978).

[26] *See* 41 FR 44209, 44210 (October 7, 1976).

[27] 40 FR 30311, 30314 (July 18, 1975); 42 FR 25755, 25756 (May 19, 1977); 43 FR 32182, 32184 (July 17, 1978).

[28] Tr. 129, 136; Ford Memorandum 12–13; See generally Tr. 29, 134–137; Ford Memorandum 12–17.

[29] Ford Memorandum 12–13.

[30] 42 U.S.C. § 7543(b)(1) (1977). Under Section 209(b)(1), the Administrator may only deny a waiver request if he finds that:

(A) the determination of the State is arbitrary and capricious,

(B) such State does not need such State standards to meet compelling and extraordinary conditions, or

(C) such State standards and accompanying enforcement procedures are not consistent with section 202(a) of this part.

[31] S. Rep. No. 403, 90th Cong., 1st Sess. 33–34 (1967).

[32] Pub L. No. 90–148, 81 Stat. 485, 501 (1967); 113 Cong. Rec. 32475 (1967).

[33] H.R. Rep. No. 728, 90th Cong. 1st Sess. 21–23, 69 (1967); *but see* "Separate Views of Messrs. John E. Moss and Lionel Van Deerlin on S. 780, The Air Quality Act of 1967," *id.* at 96–97.

[34] *Id.* at 96.

[35] *International Harvester Co.* v. *Ruckelshaus* 478 F.2d 615 (D.C. Cir. 1973).

[36] Tr. 134–136; Ford Memorandum 13–15.

[37] *International Harvester Co.* v. *Ruckelshaus, supra* note 35, at 642.

[38] *Id.* at 642.

[39] *Association of American Publishers, Inc.* v. *Governors of the United States Postal Service*, 485 F.2d 768, 773 (D.C. Cir. 1973).

[40] Tr. 136; Ford Memorandum 15.

[41] Transcript of California Waiver Hearing (January 27, 1977).

[42] 42 FR 31639, 31640 (June 22, 1978).

[43] Ford Memorandum 21; Tr. 129.

[44] I have already reviewed the feasibility of meeting the underlying NOx standards in earlier waiver decisions. *See* note 12, *supra*.

[45] Tr. 101–102.

[46] Tr. 67, 71, 73–76.

[47] Tr. 68–69, 78.

[48] Ford Memorandum 21.

[49] Tr. 126–127; "Technical Questions Concerning Highway NOx Emissions Left Open at the May 18 California Waiver Hearing," #42, submitted with a letter from Mr. D. A. Jensen, Director, Automotive Emissions and Fuel Economy Office, Ford Motor Company, to Mr. Benjamin R. Jackson, Director, MSED, EPA (June 21, 1978) [hereinafter "Ford June 21, 1978 Letter"]; Ford Memorandum 23–23. *See* "Statement of Donald A. Jensen, Director, Automotive Emissions and Fuel Economy Office, Ford Motor Company, at EPA Public Hearing Regarding California Request for Waiver of Preemption on its Highway Cycle NOx Emission Standards for 1980 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium Duty Vehicles," Attachments B & C (May 18, 1978); Letter from Mr. D. C. Kulp of Ford to Mr. B. R. Patok of EPA, Attachment IV (May 18, 1978) attached to Ford June 21, 1978 Letter.

[50] 1980 Test Procedures ¶5f; Tr. 16.

[51] *See Staff Report No. 78–1–2* at 16–20; Tr. 17–18, 172–173; CARB June 16, 1978 Letter at 4 and Attachments I & II.

[52] Tr. 127, 128; (Ford); Tr. 168–178 (Chrysler).

[53] CARB June 16, 1978 Letter.

[54] Tr. 128; Ford Memorandum 21; AMC May 9, 1978 Letter, 3–4.

[55] 1980 Test Procedures ¶5f. All emission data vehicles must be tested for highway fuel economy. *See* 40 CFR §§ 86.078–24(b), 600.002–77(a)(15), 600.010–77(a)(2).

[56] 1980 Test Procedures ¶5f; Tr. 10.

[57] Ford Memorandum 23.

[58] *Id.*

[59] *See* Tr. 21.

[60] *Staff Report 78–1–2* at 25.

[61] Ford Memorandum 18–20; Tr. 70.

[62] 43 FR 1829, 1831 (January 12, 1978).

[63] CARB June 16, 1978 Letter at 6 and Attachment II–A.

[64] 15 U.S.C. § 2002(b), (d), (e), (f) (1975); S. Rep. No. 94–516, 94th Cong., 1st Sess. 149–150 (1975).

[65] Tr. 69, 91, 128; "American Motor Corporation Comments to the May 18, 1978 EPA Waiver Hearing on the California Highway Cycle NOx Standard" at 2, submitted with AMC May 9, 1978 Letter.

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[FRL 1214–4]

Indoor Radiation Exposure Due to Radium–226 in Florida Phosphate Lands; Radiation Protection Recommendations and Request for Comment

The Environmental Protection Agency has undertaken, at the request of the Government of Florida, an investigation of indoor radiation exposure due to radium–226 in Florida phosphate lands. This investigation is now completed and the Agency publishes here its letter to the Governor setting forth its findings and recommendations, as well as a summary of an accompanying technical report. Single copies of this technical report, which details the basis for the recommendations and the Agency's findings regarding its field studies, may be obtained on request from the Director at the address below or from any EPA Regional Office.

The text of the Agency's letter follows:

Dear Governor:

On September 22, 1975, former EPA Administrator Russell E. Train wrote former Governor Askew concerning radiological impacts associated with residences constructed on phosphate lands.

Since that time, the U.S. Environmental Protection Agency and the Florida Department of Health and Rehabilitative Services have conducted independent but cooperative assessments of the situation. Both agencies have monitored individual Florida residences to determine levels of public exposure to radiation from radon gas decay products and gamma rays. We have also reviewed the health risks associated with chronic exposures to these agents. Using this information, EPA has evaluated the public health risk to Florida residents who

live in homes having elevated levels of radiation. Finally, we have identified and evaluated various control measures that could be taken to reduce indoor exposure levels and have estimated the costs likely to be associated with implementing such control measures.

My purpose in writing to you is twofold: first, to apprise you of the results of the U.S. EPA's recent study; and second, to present our recommendations regarding remedial actions that should be implemented in existing residences and also our recommendations concerning steps that should be taken to prevent public health hazards in new residences on as yet undeveloped lands.

I will begin by summarizing briefly the results of our study. More complete discussions, including the analyses which have been conducted, the assumptions which have been made, and the limitations of the analyses, are included in the enclosed "Summary of Technical Information" and detailed technical report "Indoor Radiation Exposure Due to Radium-226 in Florida Phosphate Lands." Our findings are as follows:

1. Many Florida residents who live in homes constructed on phosphate lands are exposed to levels of radioactivity which are significantly higher than normal background levels.

2. The principal radiation health threat to these residents is an increased risk of lung cancer resulting from exposure to elevated levels of radon gas decay products. The excess risk of lung cancer to these residents is dependent both on the indoor concentration of radon decay products and on the period of exposure. Specifically, it is assumed to be proportioned to the accumulated radiation dose resulting from the radon decay product exposure. In addition, it is prudent to assume that smokers and children are at greater risk than are average members of the population.

3. The EPA risk assessment analysis projects that over a 70-year (normal lifetime) period, exposure to the estimated 14,000 persons residing in approximately 4,000 Florida homes estimated to exist on phosphate lands to elevated levels of radon gas would result in approximately 150 lung cancer deaths in excess of the normal incidence of that disease. The observed incidence of fatal lung cancer in the U.S. is 3%; thus, 420 deaths from this cause would be expected in a population of some 14,000 individuals. Our analyses indicate, therefore, that persons living for a lifetime in these homes would experience an average risk of lung cancer that is roughly 35% greater than the normal risk based on U.S. health statistics.

4. Those residents who live in homes which exhibit the highest levels of radon gas contamination will experience even greater risk of lung cancer. For example, 15% of the Florida homes built on reclaimed phosphate lands were found to have an indoor radion gas concentration ranging from 0.03 to 0.10 Working Level units, or 8-25 times normal background levels. Residents who live a lifetime in these homes could experience a risk of lung cancer which is 2-4 times the average risk to a member of the U.S. population.

5. These risk projections are based on lung cancer data available from epidemiological studies of occupational workers (uranium miners and others) who have been exposed to radon decay products. While there are uncertainties associated with extrapolating these statistics to a residential population, we nevertheless believe that based on current information the risk calculations which we have made are reasonable approximations of the existing risk. We recognize also that "normal" lung cancer induction can be associated with many other agents, such as cigarette smoking, chemicals, and normal background radiation (including radon daughters). It is our conclusion, however, that these risk projections are appropriate for use as a basis for decisions on remedial actions for existing Florida residences built on phosphate lands and on preventative actions regarding lands on which future development is comtemplated.

6. There are control measures which can be implemented, where needed, in existing residences at a reasonable cost and which will significantly reduce indoor radon decay product concentrations. These are described in the accompanying technical report and its references and include such measures as sealants, improved ventilation, air cleaners, construction with crawl space, and use of clean fill. The choice of the particular method appropriate for each situation will depend upon details of construction and the characteristics of the site. The cost of these control measures is expected to range from approximately $900-2600 per affected residence over a 70-year period.

7. Future residential development on phosphate lands is likely to result in a public health hazard unless appropriate land reclamation and preparation, as well as home siting and design requirements, are imposed. Steps can be taken to reduce radon daughter and gamma radiation to near-background levels; these preventative actions can generally be accomplished at costs appreciably less than those for remedial action, and are therefore not expected to lead to significant land use restrictions. However, careful and diligent attention to proper execution of design and siting requirements will be necessary. To assure adequate protection of residents of new homes on phosphate lands, it will be necessary to conduct careful measurement programs, as well as to require bonding or comparable assurances of further remediation in the event that design and siting requirements do not result in acceptably low levels of radon daughters and gamma radiation.

8. All of the risks we have identified are based on lifetime exposures. Thus, the situation in Florida does not represent an imminent crisis. However, it does warrant early attention and action. Appropriate State and local authorities should begin to deal with exposures in residences on phosphate lands as soon as possible, with the objective that necessary remedial actions be completed in an orderly fashion within the next few years. Particular attention should be focused initially (a) on those existing residences which exhibit the highest radon decay product concentration, and (b) on State and local government actions which will assure that further residential development of phosphate lands is not permitted unless adequate land reclamation and preparation measures or siting and design measures are implemented prior to initiation of construction.

In view of these findings, I recommend that remedial action be performed in order to reduce the exposure of residents of existing homes. In addition, appropriate preventative action should be taken to avoid excessive exposures in new homes built on as yet undeveloped phosphate lands. Explicit guidance on the levels at which action should be taken and the other factors which should be considered in providing this radiation protection for persons residing on phosphate lands is contained in the enclosed recommendations.

I appreciate the fact that matters relating to radiation exposure often receive intense public attention. For this reason, I believe it would be appropriate for the EPA to hold a public meeting in the affected Florida counties for the purpose of discussing the results and the recommendations of our study. If you concur, we would propose to coordinate this public meeting with State and County representatives with whom we have worked previously on the phosphate lands issue. A notice of these recommendations will appear shortly in the Federal Register requesting public comment on these recommendations.

We are most appreciative of the cooperation that we have had with agencies of the State of Florida in this effort. This has been helpful in the development of the technical information required to support these recommendations. I would be pleased to make the appropriate staff of our Office of Radiation Programs available to you and local authorities in their consideration of these recommendations.

Sincerely yours,

Douglas M. Costle.

Recommendations for Radiation Protection of Persons Residing on Phosphate Lands

Responsible authorities should take appropriate action to ensure that the following recommendations are implemented:

I. *Remedial action should be taken in all* residences in which the initial annual indoor air concentration of radon decay products exceeds 0.02 Working Level (WL), including normal indoor background.

II. When annual average air concentrations of radon decay products are less than 0.02 WL, remedial action required to reduce such concentrations to as low as reasonably achievable levels should be taken. Among the factors to be considered in determining the appropriate degree of reduction are the cost and effectiveness of available remedial measures, the health risk averted, the normal background level, the life expectancy of the structure, and measurement uncertainties.

III. Remedial action is not warranted in existing residences solely to reduce the indoor gamma radiation exposure rate.

IV. Development sites for new residences should be so selected and prepared, and the residences so designed and sited, that the annual average indoor air concentration of radon decay products and indoor gamma radiation exposure level do not exceed average normal indoor background levels, within the uncertainties of normal background variation and measurement capability.

Explanatory Notes

1. Since the effects of exposure to radon decay products are independent of the source of exposure and are assumed to be directly related to the exposure level, the recommendations are provided in terms of total exposure and require no correction for the naturally-occurring normal background contribution. Recognition of this contribution is required, however, in making a determination of the degree of reduction attainable and warranted by control measures at levels below 0.02 WL.

2. As noted above, no absolutely safe level can be assumed for exposure to radiation. Therefore, to assure adequate public health protection, Recommendation II advises that, whenever reasonable, action be taken to reduce any health risk. For practical reasons, remedial action to achieve significant reduction of risk will not usually be justified at annual average levels less than 0.005 WL above normal indoor background.

3. For the purpose of implementing Recommendation IV, EPA has estimated average normal indoor background levels to be about 0.004 WL and 6 μR/hr in unmineralized regions in Central Florida, and the combined uncertainty due to normal variations and measurement capability to be 0.005 WL and 5 μR/hr for current available techniques. "Normal indoor background" is defined as the characteristic indoor radiation level associated with land in the proximity of but not designated as phosphate lands (i.e., in the general sense, land which does not contain elevated concentrations of radionuclides). A supplementary determination of normal background by local authorities for specific regions may be appropriate if there is reason to believe the levels to be significantly different from these values.

4. These recommendations are intended for direct application to residences and other buildings occupied for long time periods. In considering remedial action for and in designing other structures, including schools and offices, appropriate differences in occupancy factors may be considered and the above recommendations modified accordingly. However, such consideration should be biased toward assuring public health protection.

5. In the implementation of these recommendations recognition should be given to the fact that, in general, preventive measures are easier to accomplish and less expensive than are corrective measures. Therefore, particular attention should be given to land development and construction factors prior to occupancy in order to attain the lowest reasonable radon decay product levels and indoor gamma exposure rates.

"Definitions—a. "Radon-222" or "radon" is the inert radioactive gas formed by the decay of radium-226.

b. "Short-lived radon decay products" (radon daughters) are radionuclides formed in the disintegration chain of radon-222 that have short half-lives. They are polonium-218, lead-214, bismuth-214 and polonium-214. They are also called RaA, RaB, RaC, and RaC', respectively.

c. "Working Level" (WL) is the unit describing any concentration of short-lived decay products of radon-222 in one liter of air which results in the release of 1.3×10^5 MeV of potential alpha energy.

d. "Working Level Month" (WLM) is the unit describing exposure to 1 working level for 170 hours (a working month), with appropriate adjustment made for assumed breathing rates. The sum of such exposure over months or years is expressed in Cumulative Working Level Months (CWLM).

e. "Roentgen" (R) is the special unit of exposure for gamma and x-rays which is equal to electrical charges density of 2.58×10^{-4} coulombs per kilogram of air. One μR is equal to 10^{-6} Roentgens.

f. "Phosphate lands" means reclaimed, debris, and unmined lands which contain phosphate resources. Concentrations of P_2O_5 in this land need not necessarily be of economically extractable levels."

The Agency welcomes comments on these findings and recommendations relative to indoor radon exposure in both Florida and in other areas in the Nation. Comments are also requested on the technical material summarized below, as well as on procedures for implementation of these recommendations. All comments should be received by October 1, 1979 and be addressed to: Director, Criteria and Standards Division (ANR–460), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460. All written comments filed pursuant to this notice will be available for inspection and copying in the EPA Public Information Reference Unit, Room 2922, 401 M Street, S.W., Washington, D.C., during normal business hours.

For further information on this matter, contact Allan C. B. Richardson, Criteria and Standards Division (ANR–460), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460, telephone 703–557–8927.

Dated: May 30, 1979.

Douglas M. Costle,

Administrator.

Summary of Technical Information

Background—EPA provides technical assistance to the States under authority delegated to the Agency by Reorganization Plan No. 3 of 1970 to administer portions of the Public Health Service Act, as amended (42 U.S.C. 243). Under this authority, EPA initiated a study in June 1975 to determine the radiological impact of living and working in structures constructed on reclaimed phosphate mine lands in central Florida. Early data acquired by this study (see EPA Technical Note ORP/CSD 75–4, September 1975) showed elevated indoor radiation levels in some structures built on reclaimed lands compared to structures built on unmined soil. As a result of these preliminary findings, the Administrator of the Agency informed the Governor of Florida in September 1975 that a potential public health problem may exist in Florida due to elevated indoor air concentrations of radon decay products in some structures. The primary public health concern is increased risk of lung cancer. The Administrator recommended "as a prudent interim measure that the start of construction of new buildings on land reclaimed from phosphate mining areas be discouraged." To provide further guidance on this problem, on June 24, 1976, the Agency published in the Federal Register (41 FR 26066) interim recommendations for radiation levels at new structure sites on Florida phosphate lands. These interim recommendations provide for maintenance of public health protection while still allowing construction on those land areas posing only a minimal risk of significant radiation exposure.

At present, there are no Federal radiation protection guidelines for the general public specific to radium–226 in soil or to air concentrations of radon decay products. Recommendations of the former Federal Radiation Council (FRC) published in 1960 established annual whole body dose limits of 500 millirems to an individual in the general population and 170 millirems average exposure to members of representative critical subgroups of this population. These guides are not particularly useful in considering radiation protection recommendations for radon decay products because: (a) they do not apply specifically to radiation exposure from natural sources, and (b) the relationship between radon decay product air concentrations and dose equivalent to the lung is not well established.

Some guidance is provided by the U.S. Surgeon General's guidelines for remedial action in structures having uranium mill tailings under or around them. These guidelines were developed in 1970 in light of the FRC guides and risk information derived from studies of uranium miners, and cover exposure to both external gamma and indoor radon

decay products. However, in order to reflect information on the potential lung cancer risk from exposure to radon decay products developed since 1970 and to consider the specific conditions existing in Central Florida, the Agency has chosen to readdress this problem.

Rationale for the guidance—Radiation in structures built on phosphate lands consists of two components: (1) exposure of the lung to alpha radiation due to the inhalation of short-lived radon decay products, and (2) external gamma radiation exposure to the whole body. Exposure of an individual to short-lived radon decay products is measured in Cumulative Working Level Months (CWLM) which were then converted to estimates of potential health risk. Exposure to one working level in a residential environment, 75% of the time during one year, is equal to about 20 CWLM. This conversion includes a correction which considers the higher breathing rate of underground miners engaged in a higher level of physical activity than the general population. Gamma radiation exposure is measured in units of Roentgens, which when it results in a radiation dose to humans is expressed in units of dose equivalent, rems for individuals and person-rems for populations. Thse dose equivalent values were then converted to estimates of potential health risk.

For the purpose of developing radiation protection recommendations for airborne radon decay products, it is prudent to use health risk estimates derived from epidemiological studies of groups previously exposed to elevated air concentrations of these radionuclides. These data are derived primarily from studies of underground miners and lead to uncertain risk estimates when extrapolated to the general population. Nevertheless, they are judged to be sufficiently valid to be useful for making estimates for public health protection. Similarly derived estimates for the health risks associated with gamma radiation doses are available for a variety of exposed populations.

A linear, nonthreshold dose-effect relationship has been assumed to be a reasonable model for deriving risk estimates to the general public from these data, in the absence of definitive contrary information. This assumption implies that there is some finite risk to humans no matter how small the amount of absorbed radiation and that the risk at any given low dose level is directly proportional to the damage demonstrated at higher doses. In judging the acceptability of such risks, it must be considered that all persons are exposed to a large number of competing risks, including other radiation risks, and any reduction of risk from a single source must be viewed in the overall perspective of the social and economic impacts involved. Therefore, in developing these recommendations, the Agency carefully considered, in addition to the available information on health risk, the effectiveness and cost of various methods for reducing radiation exposures, and the practicality of implementation.

Scope of the guidance—These recommendations are intended to provide health protection for persons exposed to radiation in residences constructed on phosphate lands in Florida. Phosphate lands include unmined areas containing phosphate deposits, reclaimed mined areas, and any other areas containing significant quantities of residues from phosphate mining activities. The recommendations provide guidance to Federal, State, and local authorities and the public regarding unacceptable radiation exposure and for determining when remedial action is warranted in existing and new structures constructed on these lands. They contain maximum and design objective radiation exposure levels applicable to the general population from this radiation source for both exposure of the lung to alpha radiation due to the inhalation of short-lived radon decay products, and external gamma radiation exposure to the whole body. The recommended levels are expressed in terms of short-lived radon decay product air concentrations measured in Working Levels (WL) and gamma exposure rate measured in micro-Roentgens per hour (μR/h).

Guidance will be proposed at a later time to aid in evaluation of undeveloped phosphate lands. This guidance will be directed to methods for estimating post-construction levels in structures to be built on these lands. However, until this guidance is available, the interim recommendations published in the Federal Register in June 1976 (41 FR 26066) are still appropriate for the evaluation of proposed building sites.

The recommendations are not intended to supersede any existing Federal Radiation protection guides, but rather supplement these by specifying guidelines for this particular exposure situation. In developing the present recommendations only exposure due to radiation in structures was considered, since at present this appears to be the primary public health hazard. Potential crop uptake, soil runoff, and other pathways may be addressed at some future time if evaluations show these pathways to be important also.

Risk perspectives—The primary risk due to inhalation of short-lived radon decay products is lung cancer. Risks due to exposure to gamma rays are various types of fatal and nonfatal cancers and genetic damage. Health risk estimates were based upon the Agency's review of epidemiological studies conducted in several countries, including the U.S., of persons exposed to radon decay products and on findings of the Advisory Committee on the Biological Effects of Ionizing Radiations of the National Academy of Sciences (NAS–BEIR Committee) in their reports entitled "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation" (1972) and "Health Effects of Alpha Emitting Particles in the Respiratory Tract" (1976). Information in the report of the United Nations Scientific Committee on the Effects of Atomic Radiation entitled "Sources and Effects of Ionizing Radiation" (1977) was also considered.

Two types of models can be used to estimate the health risk due to exposure to radon decay products. One, commonly called the relative risk model, yields the percent increase in the normal incidence of cancer per unit exposure. The other, called the absolute risk model, yields the absolute numerical increase in cancers per unit of exposure. In the relative risk model it is assumed that risk is proportional to the age-dependent natural incidence of the disease, whereas in the absolute risk model it is assumed that the risk is independent of natural incidence. Using the relative risk model, a 3% increase in average lifetime lung cancer risk per working level month of cumulative radiation exposure was estimated as the most probable value. However, because of uncertainties in the data it is estimated that the actual increase may fall anywhere between 1–5% per working level month. Using the mean of these values for lifetime exposure to 0.02 WL (75% of the time) it is estimated that in a hypothetical population of 100,000 persons followed through their entire lifetimes there could be 2000 excess lung cancer deaths. This estimate is increased by 50% if it is assumed that children are three times more sensitive to radon decay product exposures than adults. It is decreased by about 50% if the absolute risk model is used. For either risk model, the number of years of life lost in a population of 100,000 exposed to 0.02 WL under the conditions described above is about the same—30,000 years; that is, life expectancy in the population is reduced by 0.3 years.

The risk for populations at different exposure levels or for difference occupancy periods can be estimated by proportional extrapolation. However, regardless of the models used or the assumptions made it must be recognized that, in addition to uncertainties of about a factor of two in the basic health effects data for uranium miners, there are also unquantified uncertainties in extending these results to members of the general population. These arise from significant physical, environmental, and demographic differences between the two cases. These include contributions to lung cancer induction by dusts and gases in mining environments. In addition, variations in breathing rates and equilibrium ratios of the radon daughters, and differences in population distributions due to age, sex, and personal habits, such as smoking, also affect the validity of extrapolating miner exposure data to the general population.

Gamma exposure of 0.1 rem per year over a lifetime is estimated to result in an increased fatal cancer risk of about 300 per 100,000 persons exposed, on the basis of the relative risk model.

Control costs and effectiveness—The Agency also considered the control costs which would result from implementation of these recommendations. Based upon a report published by the Agency entitled "A Preliminary Evaluation of the Control of Indoor Radon Daughter Levels in New Structures" (1976) and other available information, it is estimated that it could cost between $900 and $2600 to achieve the recommended indoor radiation levels in the majority of new or existing residences in Florida which require control action. The estimated range of costs results from the variations in construction and location of the residence and the range of potential control methods. Application of suitable control measures is estimated to result on the average in an 80% reduction in the average indoor radon decay product level and in similar reduction of indoor gamma exposure rates. On the basis of this projected control efficiency and the Agency's survey data, however, a small fraction of existing structures requiring remedial action may require special control measures resulting in costs ranging from $10,000 to $25,000 per structure.

Selection of recommendations—In developing these recommendations, the Agency attempted to meet the following objectives:

1. Minimize the health risk to the affected population.

2. Determine that recommended radiation levels can be measured with reasonable accuracy, and, when necessary, differentiated from normal background.

3. Determine that suitable control measures exist to reduce indoor radiation levels to the recommended levels.

4. Determine that application of control measures does not require the expenditure of unreasonable resources by individuals, government authorities, or other groups.

5. Determine that the recommendations can be understood and practically implemented by State and local responsible authorities and by the general public.

Present (1975) lifetime risk of lung cancer in the United States is about 3000 cancers per 100,000 persons, i.e., there is about a 3% chance that an individual will die of lung cancer during his or her lifetime (it is slightly higher in Florida). As previously noted, lifetime residency (75% occupancy) in a residence with an air concentration of 0.02 WL could result in an excess lung cancer risk of about 2000 per 100,000 exposed persons. This would increase the normal incidence by 70%.

Review of the control measures available and cost information indicates that it is feasible and, in view of the health protection gained, reasonable to reduce indoor air concentrations of radon decay product levels equal to or greater than 0.02 WL. Achievement of an 80% reduction in all cases falling above this level would result in elimination of approximately 60% of the total estimated excess risk of lung cancer projected, on the basis of EPA's limited survey of structures on these lands. The Agency recognizes that in a very few exceptional cases, costs as high as $10,000 to $25,000 per structure may be required. These will necessitate special consideration in the implementation of a remedial program, although it should be noted that the existence of such exceptional cases (a projected 1–2%) is based on a conservative projection of control efficiency, both in primary and secondary application of remedial measures. Because there are no technical difficulties in measuring radon decay product concentrations at 0.02 WL, and no other significant practical limitations, government authorities should be able to devise reasonable procedures to implement control in cases where such a level is exceeded. Further, in almost all cases, occupants of affected structures should be able to achieve these levels by selecting reasonable control measures.

The Agency also examined the reasonableness of recommending that levels lower than 0.02 WL should always be achieved. Required achievement of a significantly lower level would be likely to impose unreasonable costs in up to 15% of cases examined in the EPA survey. Nevertheless, at these levels radiation exposure should also be kept as low as reasonably achievable through the use of remedial measures. In situations observed in Florida it is usually practical to reduce exposure whenever indoor radon decay product levels are significantly above background levels. In most cases it is not unreasonable to achieve indoor radon decay product levels of less than 0.005 WL above normal indoor radon decay product background (approximately 0.004 WL in central Florida). If an 80% reduction were achieved for all cases where the initial level is greater than 0.005 WL above normal background levels, the total estimated excess risk of lung cancer for lifetime residence, projected as above, would be reduced by approximately 75%, based on the EPA/DHRS survey. The remaining excess risk is roughly equal to that attributable to normal indoor background. In order to provide flexibility to bring about remediation when costs are reasonable, remediation is recommended whenever responsible authorities determine that it is practicable to do so in the range between 0.02 WL (including normal indoor background) and 0.005 WL above normal indoor background. Although from a public health standpoint it would be desirable to reduce levels even further, the Agency has concluded that such reduction is impracticable in many situations. At indoor radon decay product levels less than 0.005 WL above normal, it becomes increasingly difficult to accurately measure and differentiate observed levels from normal background. Further, sources of radon other than those subject to these controls may contribute to the observed indoor radon decay product air concentrations. Such sources could include emanations from construction materials or infiltration from ambient air. These factors both decrease the effectiveness of control measures and increase the difficulty of implementation.

Reduction of exposure is more practical in new than in existing structures. This is because structure design, site preparation, selection of construction materials, and the location can be planned. All of these factors should be carefully considered when building new structures, particularly residences, and the builder should normally assume the responsibility of

assuring that finished structures satisfy these recommendations. State and/or local measurement programs adequate to assure that this is achieved will be required. It is possible that in a few cases following construction using what were anticipated to be appropriate control measures, the indoor radon decay product level will be above normal. In may of these cases additional controls may be warranted, but in others the lowest practical level may already be achieved. Such a determination will require a careful case-by-case review and may involve measurements over an extended period of time. Responsible State and/or local officials should therefore require bonding or comparable assurance of remediation.

The highest indoor gamma radiation dose observed in the examination of 1102 residential structures in Florida was 190 mrem/yr (29 μrem/hr, assuming 75% occupancy), which is below existing FRC guides for whole body exposure of an individual in the general public. It is not expected that a significant number of structures with indoor radiation levels much above or equal to this value will be identified. From an examination of the control cost to reduce this exposure level, it appears unreasonable to attempt reduction of such gamma levels in existing structures. However, as is the case for radon, the availability and cost of control measures for gamma radiation exposure in new residences is such that in most situations anticipated in Florida on phosphate lands it is reasonable to design and site a new residence so that the indoor gamma radiation exposure rate in the completed structure is less than 5 μR/h above normal gamma radiation background (normal is approximately 6 μR/hr). Lifetime exposure at this rate (43 mrem/y) is estimated to result in about 130 additional cancer fatalities per 100,000 persons exposed. Designing structures to achieve an indoor gamma exposure rate less than about 10 μR/hr (gross) is impractical, since differentiating between normal background and elevated levels becomes increasingly difficult below 10 μR/hr. Also, as in the case for radon daughters, other sources of radioactivity such as construction materials may be significant contributors to the overall gamma exposure at these levels. Because of high retrofitting cost, once a structure is built using a design and siting plan to minimize indoor gamma radiation exposure, no additional control is warranted for gamma reduction even if the recommended gamma ray exposure guide is exceeded.

Implementation—The U.S. Environmental Protection Agency has no authority to assure compliance with these recommendations. Implementation should be through their voluntary adoption by Federal, State, and local authorities in the form of zoning requirements, building codes, standards, or other suitable mechanisms. The recommendations may also be voluntarily implemented by property owners and occupants.

In implementing these recommendations in existing structures it will be necessary to measure indoor radon decay product air concentrations. For the recommendations applicable to new structures, gamma measurements will be needed and it will be necessary to convert the design radiation levels to measurements that can be made prior to development. Guidance on pre-construction land evaluation is currently being developed by the Agency, and is presently scheduled to be proposed in 1979.

Indoor air concentrations of radon decay products should be measured using a Radon Progeny Integrating Sampling Unit (RPISU) or other systems capable of comparable accuracy in estimating representative average concentrations. From the Agency's field studies Florida, we have found that if the RPISU or a similar system is used, the average indoor radon decay product level for a structure can be estimated by using the mean of at least four to six measurements made over a one-year period. Single measurements of less than 24 hours integrating time or multiple measurements totaling less than 125 hours have limited value in determining the average indoor radon decay product level. Devices such as instantaneous working level meters, grab radon or radon decay product samples, and track-etch films may be helpful in screening structures to determine those most likely to exhibit elevated indoor radon decay product air concentrations. However, they may not provide sufficiently accurate or representative average exposure data to be used for remedial action decisionmaking, unless the data are shown to be of quality comparable to that determined from devices such as the RPISU. The radiation detection instruments should be located in a part of the structure which would reasonably represent normal living conditions. Closets or other marginally ventilated areas are, in general, not good locations.

The recommendations provide that when the radon daughter product level in existing homes is less than 0.02 WL (including normal background indoors), action be taken to reduce the radon concentration to as low as reasonably achievable levels. It is recognized that a discretionary policy such as this may complicate implementation of the recommendations, since decisions must be made regarding which exposure level can be considered as low as reasonably achievable for each structure. To assist in making such decisions several factors should be considered:

1. The magnitude of the annual average indoor radon decay product level should be compared to the recommendations. The closer an observed level approaches background levels, the less reasonable is an effort to reduce it.

2. The reliability of the data should be evaluated. How much error is in the measurement? Is more accurate data required to make a decision? At levels near 0.005 WL above normal indoor background a generic decision on remediation for similar cases may be appropriate to minimize unproductive costs for refining of measurements.

3. The cost to reduce the level should be evaluated. If the cost is minimal then any reduction the level would be desirable. However, if the cost is substantial then the potential decrese in risk must be weighed against the cost to determine if the application of the control is warranted.

4. Any potential impact of the residence on future inhabitants should be considered. If the structure is very old and in poor condition and is unlikely to be inhabited to any significant degree in the future, it can be expected to have less long-term impact on public health.

5. The social and economic inconvenience to the inhabitants should be considered. Some residents may find expenditures to install control technology prohibitive and a major disruption to their life styles.

These factors have not been placed in order of importance because they will vary from case to case and may not even represent all factors to be considered. Thus, the decision on appropriate remedial action below 0.02 WL in existing homes is in reality a judgment of what appears most reasonable for the present and future occupants.

Projected impact of the recommendations—Implementation of the recommendations will have a broad range of health, economic, sociological, and other impacts on the areas affected. These impacts can be evaluated only on a qualitative basis at present because the actual number of structures involved, the field effectiveness of control measures and their specific

costs, and the availability of financial aid for remedial action are among several factors not totally known.

About 150,000 acres of land have been mined for phosphate rock. Of that amount, about 50,000 acres have been reclaimed to various degrees. About 5,000 acres are newly mined each year. Estimates suggest that approximately 7,500 acres are now being used for residential housing or commercial purposes. The total unmined acreage which contains elevated radium-226 concentrations near the surface is at present unknown, but preliminary investigation indicates it may be quite large.

The Florida Department of Health and Rehabilitative Services has estimated that 4,000 structures have been built on phosphate lands in Polk and Hillsborough Counties.

The recommendations could negatively affect property values and availability of housing due to the reluctance of builders to utilize phosphate lands, and perhaps a reluctance to purchase houses that have had remedial action for radiation level reduction. The actual magnitude of this impact is dependent upon the availability of alternative construction sites, the willingness of builders to incorporate remedial measures in housing design, and the attitude of residential buyers toward impacted residences and land.

The additional workload on local government agencies to implement the proposed recommendations could be significant, at least initially. There will be a need for additional inspections, surveying and recordkeeping, and other peripheral support activities including an available laboratory for radiological analyses. It is estimated to cost about $50–100 to conduct a detailed evaluation of the radiation levels in each structure. Rapid screening of structures to isolate the most affected structures should be considerably less expensive. If 4,000 structures require detailed evaluation, this is estimated to cost $200,000–400,000. These values could vary depending upon the present capabilities of the local agencies.

There may be a negative impact on community tax structures due to the recommendations. First, there may be a loss of tax base due to a decrease in residential or commercial development. Second, an increased local revenue may be needed to support any remedial action program operated by local government.

There will also be impacts on residents of affected structures and those planning future housing purchases. Depending upon the type of control technology used, residents may have some degree of disruption of their life styles either through the initial installation of the remedial measure or any periodic maintenance required over the ensuing years. The cost of the remedial action may also have to be assumed fully, or in part, by the homeowner.

From the air sampling data collected, the total cost for implementating the recommendations for 4,000 existing structures can be projected. With 0.02 WL (including background) as the minimum control level, approximately 20 percent of the total sample, or 800 structures out of the estimated 4,000 structures, is projected to require remedial action. In addition, up to ½ percent of structures may require special corrective action to meet this control level at a total cost of $200,000–$500,000. At a maximum control level of 0.005 WL above indoor background, approximately 40 percent of existing structures, or a total of 1,600 structures, would require remedial action. Assuming an average remedial cost per structure of approximately $1,500 for normal remediation, a total cost range of $200,000–$2,900,000 is projected for the limiting criteria levels.

Statistics are not readily available on the number of new structures being built on or projected for phosphate lands. However, a rough estimate can be made on the basis of annual housing starts for those cities and towns located in the vicinity of identified phosphate areas. Data published by the Bureau of the Census indicates approximately 400 housing starts within incorporated municipalities located in phosphate areas of Polk and Hillsborough Counties for 1976. There were 3,012 housing starts in unincorporated areas of both counties in 1976. Approximately 50 in Hillsborough County and 950 in Polk County are assumed to be located in the defined phosphate area based on information from the respective county building permit offices. Of the 1,400 total new housing starts, as many as 40 percent might require some control measures to meet the recommended design objectives for radon decay products, based on the measured distribution of levels in existing structures. Therefore, about 500 structures per year or about 15 percent of new residential construction starts in the two counties may require precautionary radon control action. Over a ten-year period the cost of control could be about $2,500,000, assuming $500 per structure. About 250 structures per year could require some control measures to meet the gamma exposure design objectives. Over a ten-year period the cost of precautionary gamma exposure control could be about $1,400,000 in the two counties. In some structures, control of radon decay product levels could also control gamma exposures and thus reduce the overall potential control costs. Other counties may be affected depending upon the extent of phosphate lands and future decisions regarding their use.

The economic impact of a remedial and precautionary action program in Polk and Hillsborough Counties for a ten-year period could total about 4.5 to 5.5 million dollars (undiscounted 1977 dollars) for existing and new structures. Because of the relatively low cost of control measures, compared to overall structure costs, implementation of the recommendations should not seriously affect long-term development of housing in the Central Florida area.

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EQUAL EMPLOYMENT OPPORTUNITY COMMISSION

Equal Pay Act Administration

Pursuant to Reorganization Plan No. 1 of 1978, 43 FR 19807 (May 9, 1978), responsibility and authority for enforcement of the Equal Pay Act of 1963, 29 U.S.C. § 206(d), is transferred from the Department of Labor to the Equal Employment Opportunity Commission effective July 1, 1979. The Commission has voted to adopt certain procedures regarding administration of the Equal Pay Act. These procedures are effective July 1, 1979, and are as follows:

(a) The Commission has adopted the Department of Labor's procedures for administrative investigation and enforcement under the Equal Pay Act.

(b) As provided in sections 9, 11, 16, and 17 of the FLSA, the Commission and its authorized representatives under the Act may (1) investigate and gather data; (2) enter and inspect establishments and records, and make transcriptions thereof, and interview individuals; (3) advise employers regarding any changes necessary or desirable to comply with the Act; (4) subpoena witnesses and order production of documents and other evidence; (5) supervise the payment of amounts owing pursuant to section 16(c) of the FLSA; (6) initiate and conduct litigation.

(c) The General Counsel, District Directors, the Director of Field Services, and the Director of Systemic Programs, or the designees of any of them are hereby delegated authority to exercise